Japanese Patent Application Laid Open No. 2001-298661
Laid-Opened Date: October 26, 2001
Application Number: 2000-112347
Filing Date: April 13, 2000
Applicant: SONY CORP
Inventor: TAKUYA CHIBA

TITLE OF THE INVENTION

IMAGE PROCESSING APPARATUS, IMAGE PROCESSING APPARATUS COMPENSATION METHOD, AND RECORDING MEDIUM

ABSTRACT OF THE DISCLOSURE

Problem: compensate for loss of light resulting from the operation of closing a mechanical shutter when in high speed shutter mode.

Solution: a light emitting body, which emits a fixed brightness, is imaged, while a mechanical shutter is opened, by opening an electronic shutter for a prescribed exposure time Y3 of the high speed shutter operation at a prescribed aperture stop value α. The camera microprocessor records into memory a value of a light quantity D that is inputted at the time thereof by way of the integral computation circuit when no light quantity loss occurs, as per Fig. 10 (A). Next, the mechanical shutter is operated at the same exposure time Y3 and the aperture stop value α, and the light emitting body, which emits a fixed brightness, is

imaged thereby. The integral value of the received light quantity when a light loss is present is treated as a light quantity D′, as depicted in Fig. 10 (B). Thus, the timing of the commencement of the exposure is changed, and a timing of the commencement of the exposure Tn of the exposure timing Yn, when D = D′, is recorded in the memory as the value of the compensation of the shutter timing for the prescribed exposure time Y3 of the high speed shutter operation.

#1 Operation of Mechanical Shutter

#2 Operation of Electronic Shutter

#3 Received Light Quantity With Regard to Aperture Stop Value α

#4 Voltage Discharge

#5 Timing of Commencement of Exposure T1

#6 Exposure Time Y3

#7 Light Quantity D

#8 Time

#9 Operation of Mechanical Shutter

#10 Operation of Electronic Shutter

#11 Received Light Quantity With Regard to Aperture Stop Value α

#12 Voltage Discharge

#13 Light Quantity D′

#14 Time

#15 Operation of Mechanical Shutter

#16 Operation of Electronic Shutter

#17 Received Light Quantity With Regard to Aperture Stop Value α

#18 Voltage Discharge

#19 Timing of Commencement of Exposure Tn

#20 Mechanical Shutter Operation Instruction Pulse

#21 Light Quantity D′

#22 Exposure Time Yn

#23 Closing Time Tclose

#24 Time

WHAT IS CLAIMED IS:

1. An image processing apparatus, comprising:

an adjustment unit configured to adjust a light quantity of a light that is inputted by way of a lens;

a shutter unit configured to shutter the light, the light quantity whereof is adjusted by the adjustment unit;

a first control unit configured to control an operation timing of the shutter unit;

a conversion unit configured to receive, and to convert to an electrical signal, the light that is adjusted by the adjustment unit;

a second control unit configured to control an operation timing of the conversion unit;

a computation unit configured to compute, from the electrical signal that is converted by the conversion unit, an integral value of the light quantity that is received by the conversion unit;

a control information generation unit configured to generate, from the integral value of the light quantity that is computed by the computation unit, and with respect to a plurality of imaging states that is controlled by either the adjustment unit, the first control unit, or the second control unit, a control information for compensating for a loss quantity of the integral value of the light quantity for an integral

value of a light quantity that is optimal for an imaging; and

a recording control unit configured to control a recording of the control information that is generated by the control information generation unit.

2. The information processing apparatus according to claim 1, wherein:

the computation unit computes a first integral value of a light quantity, wherein the cover unit is controlled by the first control unit so as not to cover a light, and a second integral value of a light quantity, wherein the cover unit is controlled by the first control unit so as to cover the light at a prescribed timing; and

the control information generation unit computes an operation time of the shutter unit and the loss quantity of the light quantity, and generates the control information thereof, by comparing the first integral value of the light quantity and the second integral value of the light quantity that is computed by the computation unit.

3. The image processing apparatus according to claim 2, wherein:

the control information is a compensation value of an operation timing of the shutter unit that is

controlled by the first control unit.

4. The image processing apparatus according to claim 2, wherein:

the control information is a compensation value of an operation timing of the conversion unit that is controlled by the second control unit.

5. The information processing apparatus according to claim 1, wherein:

the computation unit computes, with respect to a prescribed operation timing of the conversion unit that is controlled by the second control unit, a third integral value of a light quantity wherein the cover unit is controlled by the first control unit so as not to cover a light, and a fourth integral value of a light quantity wherein the cover unit is controlled by the first control unit so as to cover the light, while changing an operation timing of the conversion unit by way of the second control unit; and

the control information generation unit compares the third integral value of the light quantity, and the fourth integral value of the light quantity, that is computed by the computation unit, and treats the operation timing of the conversion unit as the control information when the third integral value of the light quantity is equivalent to the fourth integral value of

the light quantity.

6. An image processing apparatus compensation method, comprising the steps of:

controlling an adjustment of a light that is inputted by way of a lens;

controlling a shuttering of the light that is adjusted by the adjustment control step;

controlling a process timing of the shutter control step;

controlling a process of converting, to an electrical signal, the light, the light quantity whereof is adjusted by a process of the adjustment control step;

controlling a process timing of the conversion control step;

computing, from the electrical signal, the conversion whereof is controlled by a process of the conversion control step, an integral value of the light quantity, the conversion whereof into the electrical signal is controlled by a process of the conversion control step;

generating, from the integral value of the light quantity that is computed by a process of the computation step, and with respect to a plurality of imaging states that is controlled by a process of the adjustment control step, a process of the first control

step, or a process of the second control step, a control information for compensating for a loss quantity of the integral value of the light quantity for a light quantity that is optimal for an imaging; and

controlling a recording of the control information that is generated by a process of the control information generation step.

7. A recording medium configured such that whereupon is recorded a computer readable program, comprising the steps of:

controlling an adjustment of a light that is inputted by way of a lens;

controlling a shuttering of the light that is adjusted by the adjustment control step;

controlling a process timing of the shutter control step;

controlling a process of converting, to an electrical signal, the light, the light quantity whereof is adjusted by a process of the adjustment control step;

controlling a process timing of the conversion control step;

computing, from the electrical signal, the conversion whereof is controlled by a process of the conversion control step, an integral value of the light

quantity, the conversion whereof into the electrical signal is controlled by a process of the conversion control step;

generating, from the integral value of the light quantity that is computed by a process of the computation step, and with respect to a plurality of imaging states that is controlled by a process of the adjustment control step, a process of the first control step, or a process of the second control step, a control information for compensating for a loss quantity of the integral value of the light quantity for a light quantity that is optimal for an imaging; and

controlling a recording of the control information that is generated by a process of the control information generation step.

DETAILED DESCRIPTION OF THE INVENTION

[0001]

FIELD OF THE INVENTION

The present invention relates to an image processing apparatus, an image processing apparatus compensation method, and a recording medium, and in particular, to an image processing apparatus, an image processing apparatus compensation method, and a recording medium, with respect to a digital camera that comprises a mechanical shutter function, that is

capable of compensating, with a high degree of precision, for a light quantity loss resulting from a closing operation of the mechanical shutter that comprises a fixed misalignment, irrespective of a shutter speed or an aperture stop value of an electronic shutter.

[0002]

Description of the Related Art

As a number of pixels of a digital camera increases, a charge-coupled device (CCD) of an interlace operation is seeing an increase in usage therewith. An interlace operation refers to an operation wherein an even-numbered line is scanned after an odd-numbered line being scanned, and a CCD of an interlace operation is capable of increasing a photosensitive surface thereof, and thus, comprises a high degree of sensitivity. With respect to a digital camera that employs the CCD of the interlace operation thereof, an image data that corresponds to a single imaging is generated by an odd field that is formed from a pixel of the odd-numbered line thereof and an even field that is formed from a pixel of the even-numbered line thereof.

[0003]

The CCD converts an intensity of a light that is received thereby into an electrical signal, which it outputs therefrom. An output timing thereof is

controlled by an electronic shutter. Normally, the electronic shutter performs an operation that treats a light as being incident to the CCD, causes a voltage immediately prior to causing the shutter to operate to discharge into a substrate, and causes an intake of an electrical signal for a prescribed time interval thereafter. The operation thereof is performed in accordance with an input timing of a vertical synchronization signal. After a still image is photographed, a reading out of an electrical signal that corresponds to an image of the odd field commences at a time of an input of a next vertical synchronization signal, and a reading out of an electrical signal that corresponds to an image of the even field commences at a time of an input of a next vertical synchronization signal thereafter, such as is depicted in Fig. 1 (A).

[0004]

As depicted in Fig. 1 (A), when the light is inputted into the CCD and accumulated thereupon, both when reading out the odd field and the even field alike, the light quantity that is accumulated upon the CCD varies when the odd field is read out versus when the even field is read out, and an unnatural image, comprising a brightness that differs from an instant of an imaging thereof, ends up being generated when the odd field is composited with the even field to obtain a

single image data therefrom.

[0005]

In order that such a phenomenon does not occur, a mechanical shutter is employed, which shutters the light in order to prevent the CCD from receiving an excess of light when reading out the odd field and the even field. As depicted in Fig. 1 (B), preventing the CCD from receiving the light by closing the mechanical shutter prior to commencing the reading out of the odd field, or put another way, after the imaging of the still image, and prior to the next vertical synchronization signal being inputted, allows treating the light quantity that is accumulated upon the CCD when reading out the odd field and the even field as identical to a light quantity when the imaging is performed thereby.

[0006]

Fig. 2 depicts a configuration of a component with respect to a digital camera, comprising a mechanical shutter function, which comprises a photosensitive function. In Fig. 2 (A), a received light quantity of a light that is inputted thereto by way of a lens 1 is adjusted by an iris/mechanical shutter 2, which incorporates the mechanical shutter function thereof, and the received light quantity thus adjusted is thereby incident to a CCD 3. The light that is incident to the CCD 3 is thus shuttered by the

iris/mechanical shutter 2 being closed at a prescribed timing that is described with reference to Fig. 1 (B). In Fig. 2 (B), the light quantity of the light that is inputted thereto by way of the lens 1 is adjusted by an iris 4, and is thereby incident to the CCD 3. Thereafter, the light that is incident to the CCD 3 is shuttered by a mechanical shutter 5, which is closed at a prescribed timing that is described with reference to Fig. 1 (B). Both the iris/mechanical shutter 2 and the mechanical shutter 5 are operated at a high speed by being driven by such as a spring or a motor (not shown).

[0007]

An exposure, i.e., an exposure value, at a time of an imaging, is determined by an integral of an aperture stop value and a shutter speed, i.e., an exposure time. Put another way, the shutter speed of the electronic shutter of the CCD 3 and an aperture opening of either the iris/mechanical shutter 2 or the iris 4 is determined by the brightness of the image that is being imaged. If the image that is being imaged is dark, then either the shutter speed is slowed down or an aperture opening of the aperture stop is opened, in order to obtain an adequate light quantity. If, on the other hand, the image that is being imaged is bright, then either the shutter speed is slowed down or the aperture opening of the aperture stop is reduced, in order that an excessive exposure is not taken. The

exposure of the digital camera is determined by an auto exposure (AE) mechanism. The AE mechanism measures a brightness of each respective component of a field that is to be photographed, and sets the exposure to be such that an average of the measurement thereof will be a prescribed brightness thereof. In addition, the digital camera comprises an exposure compensation function, which compensates the exposure thereof in order to take the photograph at a brightness that a user has in mind.

[0008]

Normally, a system is employed wherein a combination of the aperture stop value and the shutter speed is determined with regard to the brightness, a plurality of combinations thereof with regard to a common exposure is preset, and the user selects a desired combination of the aperture stop value and the shutter speed from the plurality of combinations thereof. A system thereof is generally referred to as a program AE mechanism. With regard thereto, an AE mechanism that designates the aperture stop, and sets the shutter speed that corresponds to the aperture stop thus designated, is referred to as an aperture stop priority AE mechanism. Conversely, an AE mechanism that designates the shutter speed, and sets the aperture stop that corresponds to the shutter speed thus designated, is referred to as a shutter speed priority AE mechanism.

[0009]

It is to be understood that, when describing a component with regard to the operation of the iris/mechanical shutter 2 hereinafter, which is unrelated to the aperture stop, and which relates to the operation of the mechanical shutter, a circumstance wherein distinguishing between the iris/mechanical shutter 2 and the mechanical shutter 5 is not especially necessary, the component thus described will simply be referred to as the mechanical shutter, in contrast to the electronic shutter of the CCD 3.

[0010]

PROBLEMS THAT THE INVENTION IS INTENDED TO SOLVE

The mechanical shutter that is described with reference to Fig. 1 and Fig. 2 must be completely closed before the reading out of the image data commences. A certain amount of time is required, however, from the mechanical shutter commencing a closing operation thereof until the closing thereof is completed, and the received light quantity of the CCD 3 declines during an interval thereof. Put another way, if a timing of ending the exposure is called t1, such as is depicted in Fig. 3, and an attempt is made to match the closing timing wherein the closing operation of the mechanical shutter is completed to the timing t1 thereof, a light loss occurs with regard to the light quantity that is actually desired for the exposure, in

accordance with the closing operation of the mechanical shutter thereof; in the present circumstance, the light quantity that is lost will be referred to as the light loss quantity. Accordingly, an inadequate exposure results, causing a dark image to be imaged thereby.

[0011]

Thus, a misalignment arises from a fixed misalignment, of either the iris/mechanical shutter 2 of the digital camera that employs the imaging unit as described with reference to Fig. 2 (A), or of the mechanical shutter 5 of the digital camera that employs the imaging unit as described with reference to Fig. 2 (B), and which includes a fixed misalignment of the spring or the motor that drives either the iris/mechanical shutter 2 or the mechanical shutter 5, during the closing time thereof.

[0012]

The light loss quantity varies as the closing time of the mechanical shutter and the light quantity of at the time of the exposure, i.e., the aperture stop value. Thus, with the digital camera that employs the imaging unit as described with reference to Fig. 2 (A), the aperture stop is determined by the aperture opening of the iris/mechanical shutter 2 at the time of imaging thereby, whereas with the digital camera that employs the imaging unit as described with reference to Fig. 2 (B), the aperture stop is determined by the aperture

opening of the iris 4 at the time of imaging thereby. Put another way, when the aperture stop is in a state of being opened, the light loss quantity increases thereby. In addition, when the aperture stop is in the state of being opened, an operation range of the iris/mechanical shutter 2 increases with respect to the digital camera that employs the imaging unit as described with reference to Fig. 2 (A), and thus, an effect resulting from the fixed misalignment increases more thereupon than under a circumstance wherein the imaging is performed with the aperture stop being comparatively closed.

[0013]

It is necessary for a mechanical shutter operation instruction pulse, which is a signal that instructs a driver (not shown) that drives the mechanical shutter to open and close the mechanical shutter, to occur in such a manner as to take into account a delay time t3 - t2, which is from a mechanical shutter operation instruction pulse generation timing t2 to a timing t3 wherein a mechanical closing of the mechanical shutter commences, and a closing time of the mechanical shutter t1 - t3.

[0014]

As an instance thereof, a technology exists that compensates for the timing when the signal for the driving of the mechanical shutter is generated, such

that the timing of the completion of the closing of the shutter invariably occurs prior to the commencement of the reading out of the image, even when the mechanical shutter comprises the fixed misalignment. The compensation thereof, however, compensates for the delay time t3 - t2 that is described with reference to Fig. 3, and does not take into account a misalignment of the light loss quantity that arises from the aperture stop value at the time of the imaging, or from the fixed misalignment of the iris/mechanical shutter 2 or the mechanical shutter 5 thereupon, and thus, even if the timing of the completion of the closing of the shutter is controlled so as to occur invariably prior to the commencement of the reading out of the image, a timing of a completion of the exposure time ends up occurring after the commencement of the operation of the closing of the mechanical shutter, and thus, the exposure quantity that is obtained thereby for the imaging thereof is inadequate.

[0015]

Furthermore, when employing a high speed shutter function for the imaging, wherein the exposure time is shorter than the closing time thereof, the light loss quantity varies as the exposure time, as well as the aperture stop value and the time of the closing of the mechanical shutter. As described herein, the exposure time is determined by the shutter speed of the

electronic shutter. With respect to the conventional technology thereof, however, an operation of the high speed shutter is not taken into account therein. Put another way, when an imaging is performed at a shutter speed of the electronic shutter that differs from a shutter speed of the electronic shutter at a time of measuring of a timing of the driving of the mechanical shutter, a control is performed so as to shift an exposure commencement location by a degree to which the shutter speed thereof varies, and thus, it has been impossible to compensate, with a high degree of precision, for the light loss quantity of a digital camera comprising the high speed shutter function thereof, such as is described with reference to Fig. 4.

[0016]

The present invention was devised with a circumstance such as is described herein in mind, and is capable of compensating, with a high degree of precision, for a light quantity loss resulting from a closing operation of a mechanical shutter comprising a fixed misalignment for a digital camera comprising a mechanical shutter function, regardless of a shutter speed or an aperture stop value of an electronic shutter thereof.

[0017]

MEANS TO SOLVE THE PROBLEMS

An image processing apparatus according to the

present invention comprises an adjustment unit that adjusts a light quantity of a light that is inputted by way of a lens, a shutter unit that shutters the light, the light quantity whereof is adjusted by the adjustment unit, a first control unit that controls an operation timing of the shutter unit, a conversion unit that receives, and converts to an electrical signal, the light that is adjusted by the adjustment unit, a second control unit that controls an operation timing of the conversion unit, a computation unit that computes, from the electrical signal that is converted by the conversion unit, an integral value of the light quantity that is received by the conversion unit, a control information generation unit that generates, from the integral value of the light quantity that is computed by the computation unit, and with respect to a plurality of imaging states that is controlled by the adjustment unit, the first control unit, or the second control unit, a control information for compensating for a loss quantity of the integral value of the light quantity for an integral value of a light quantity that is optimal for an imaging, and a recording control unit that controls a recording of the control information that is generated by the control information generation unit.

[0018]

In addition, it is possible for the computation

unit to compute a first integral value of a light quantity, wherein the cover unit is controlled by the first control unit so as not to cover a light, and a second integral value of a light quantity, wherein the cover unit is controlled by the first control unit so as to cover the light at a prescribed timing, and it is possible for the control information generation unit to compute an operation time of the shutter unit and the loss quantity of the light quantity, and to generate the control information, by comparing the first integral value of the light quantity and the second integral value of the light quantity that is computed by the computation unit.

[0019]

In addition, it is possible for the control information to be treated as a compensation value of an operation timing of the shutter unit that is controlled by the first control unit.

[0020]

In addition, it is possible for the control information to be treated as a compensation value of an operation timing of the conversion unit that is controlled by the second control unit.

[0021]

In addition, it is possible for the computation unit to compute, with respect to a prescribed operation timing of the conversion unit that is controlled by the

second control unit, a third integral value of a light quantity wherein the cover unit is controlled by the first control unit so as not to cover a light, and a fourth integral value of a light quantity wherein the cover unit is controlled by the first control unit so as to cover the light, while changing an operation timing of the conversion unit by way of the second control unit, and it is possible for the control information generation unit to compare the third integral value of the light quantity and the fourth integral value of the light quantity that is computed by the computation unit, and to treat the operation timing of the conversion unit as the control information when the third integral value of the light quantity is equivalent to the fourth integral value of the light quantity.

[0022]

An image processing apparatus compensation method according to the present invention comprises the steps of controlling an adjustment of a light that is inputted by way of a lens, controlling a shuttering of the light that is adjusted by a process of the adjustment control step, controlling a process timing of the shutter control step, controlling a process of converting, to an electrical signal, the light, the light quantity whereof is adjusted by a process of the adjustment control step, controlling a process timing

of the conversion control step, computing, from the electrical signal, the conversion whereof is controlled by a process of the conversion control step, an integral value of the light quantity, the conversion whereof into the electrical signal is controlled by a process of the conversion control step, generating, from the integral value of the light quantity that is computed by a process of the computation step, and with respect to a plurality of imaging states that is controlled by a process of the adjustment control step, a process of the first control step, or a process of the second control step, a control information for compensating for a loss quantity of the integral value of the light quantity for a light quantity that is optimal for an imaging, and controlling a recording of the control information that is generated by a process of the control information generation step.

[0023]

A program that is recorded upon a recording medium according to the present invention comprises the steps of controlling an adjustment of a light that is inputted by way of a lens, controlling a shuttering of the light that is adjusted by the adjustment control step, controlling a process timing of the shutter control step, controlling a process of converting, to an electrical signal, the light, the light quantity whereof is adjusted by a process of the adjustment

control step, controlling a process timing of the conversion control step, computing, from the electrical signal, the conversion whereof is controlled by a process of the conversion control step, an integral value of the light quantity, the conversion whereof into the electrical signal is controlled by a process of the conversion control step, generating, from the integral value of the light quantity that is computed by a process of the computation step, and with respect to a plurality of imaging states that is controlled by a process of the adjustment control step, a process of the first control step, or a process of the second control step, a control information for compensating for a loss quantity of the integral value of the light quantity for a light quantity that is optimal for an imaging, and controlling a recording of the control information that is generated by a process of the control information generation step.

[0024]

With respect to the image processing apparatus, the image processing apparatus compensation method, and the program that is recorded upon the recording medium, according to the present invention, a light that inputted by way of a lens is controlled, the light is shuttered, a timing of the shuttering thereof is controlled, the light is converted into an electrical signal, a timing of the conversion thereof is

controlled, an integral value of a light quantity is computed from the electrical signal, a control information is generated from the integral value of the light quantity thus computed, and with respect to a plurality of imaging states, in order to compensate for a loss quantity of the integral value of the light quantity for a light quantity that is optimal for an imaging, and a recording of the control information thus generated is controlled.

[0025]

EMBODIMENTS OF THE INVENTION

Following is a description of embodiments of the present invention, with reference to the attached drawings.

[0026]

Fig. 5 is a block diagram depicting a configuration of a component that performs a control relating to a light reception of a digital camera, wherein the present invention is applied. In the present circumstance, a description hereinafter will refer to a digital camera employing an iris/mechanical shutter 2 that is described with reference to Fig. 2 (A).

[0027]

Prior to an imaging of an image, in order to perform an auto exposure (AE), a CCD 3 converts, at each instance of a given frequency, a light that is

incident thereto by way of the a lens 1 and the iris/mechanical shutter 2 into an electrical signal, and supplies the electrical signal thus converted to an analog/digital (A/D) conversion and auto gain control (AGC) circuit 11. The analog/digital (A/D) conversion and auto gain control (AGC) circuit 11 converts the signal that is inputted thereto from the CCD 3 to a digital signal, amplifies the signal thus converted in accordance with a gain control value that is inputted thereto from a camera microprocessor 12, and outputs the signal thus converted and amplified to a signal processing circuit 13. An integral value computation circuit 22 of the signal processing circuit 13 computes, from an image data that is inputted thereto, an integral value of a received light quantity that corresponds to a single image, and supplies the integral value thus computed to the camera microprocessor 12.

[0028]

The camera microprocessor 12 performs the AE process, in accordance with the integral value of the received light quantity that is inputted thereto from the integral value computation circuit 22 of the signal processing circuit 13, and determines a shutter speed and an aperture stop value of the electronic shutter that corresponds to a brightness of the image data that is inputted thereto. A situation will be described

hereinafter wherein, in the present circumstance, an aperture stop priority AE, which determines the shutter speed of the digital camera for the aperture stop value, is performed.

[0029]

In addition, the integral value computation circuit 22 computes, from an image data that is inputted thereto, an integral value of a received light quantity that corresponds to a single image, with respect to a measurement of a closing time of a mechanical shutter or a measurement of a light loss quantity (to be described hereinafter), and supplies the integral value thus computed to the camera microprocessor 12. The camera microprocessor 12 computes a compensation value of a shutter timing in accordance with the integral value of the received light quantity that is inputted thereto from the integral value computation circuit 22; a detailed description with regard to the compensation of the shutter timing thereof will be provided hereinafter.

[0030]

The camera microprocessor 12 comprises a memory 21 therewithin, which is formed, as an instance thereof, from an Electrically Erasable Programmable Read Only Memory (EEPROM), and records thereupon the aperture stop value and the shutter speed of the electronic shutter that is determined by the AE mechanism, as well

as the compensation value of the shutter timing thereof (to be described hereinafter).

[0031]

When a user employs such as a console unit (not shown) to instruct the imaging of the image, the camera microprocessor 12 receives an input of an imaging instruction signal from a control circuit (not shown), and generates a mechanical shutter operation timing information, an electronic shutter control signal, an aperture stop control signal, and a gain control value, in accordance with the aperture stop value, the shutter speed, and the compensation value of the shutter timing, which is computed by the AE mechanism and recorded upon the memory 21. Thus, the camera microprocessor 12 outputs the mechanical shutter operation timing information to a mechanical shutter operation instruction pulse generation circuit 23 of the signal processing circuit 13, outputs the electronic shutter control signal to a timing generator 14, outputs the aperture stop control signal to a driver 15, and outputs the gain control value to the analog/digital (A/D) conversion and auto gain control (AGC) circuit 11.

[0032]

A basic operation clock cycle is supplied to the timing generator 14, as an instance thereof, by such as liquid crystal transmitter (not shown), and, in accordance therewith, the timing generator 14 generates

a horizontal and a vertical synchronization signal, supplies the signal thus generated to the signal processing circuit 13, receives an input thereto of the electronic shutter control signal from the camera microprocessor 12, generates an electronic shutter drive signal, and outputs the electronic shutter drive signal thus generated to the CCD 3.

[0033]

The mechanical shutter operation instruction pulse generation circuit 23 generates the mechanical shutter operation instruction pulse in accordance with the mechanical shutter operation timing information that is inputted thereto from the camera microprocessor 12, and outputs the mechanical shutter operation instruction pulse thus generated to the driver 15. The driver 15 receives an input thereto from the camera microprocessor 12 of the aperture stop control signal, and generates an iris drive signal, and also receives an input thereto from the signal processing circuit 13 of the mechanical shutter operation instruction pulse, generates a mechanical shutter drive signal, and outputs the iris drive signal and the mechanical shutter drive signal thus generated to the iris/mechanical shutter 2. The iris/mechanical shutter 2 determines an aperture opening in accordance with the iris drive signal that is received therewith, restricts a received light quantity of the CCD 3, closes an

aperture opening unit, and shutters a light that is incident to the CCD 3, in accordance with the mechanical shutter drive signal; put another way, the iris/mechanical shutter 2 closes the mechanical shutter.

[0034]

The received light quantity of the light that is incident by way of the lens 1 is restricted by the iris/mechanical shutter 2, and is incident thereby to the CCD 3. The CCD 3 converts an intensity of the light that is inputted thereto into an electrical signal, and when the electronic shutter drive signal is inputted thereto from the timing generator 14, discharges a voltage that has thus far been accumulated thereupon into a substrate, and converts, into an electrical signal, an intensity of a light that is accumulated over a given period of time in accordance with the electronic shutter drive signal, or, put another way, a prescribed exposure time interval, and supplies the electrical signal thus converted to the analog/digital (A/D) conversion and auto gain control (AGC) circuit 11. The analog/digital (A/D) conversion and auto gain control (AGC) circuit 11 converts the signal thus supplied thereto from the CCD 3 into a digital signal, amplifies the signal thus converted according to the gain control value that is inputted thereto from the camera microprocessor 12, and outputs the digital signal thus converted and amplified to the signal

processing circuit 13.

[0035]

The signal processing circuit 13 carries out, as an instance thereof, a prescribed process, such as a noise reduction, upon an image signal that is inputted thereto, supplies the image signal thus processed to an image processing circuit (not shown), and, as an example thereof, outputs the image data thus imaged to a monitor (not shown), or records the image data thus imaged to a recording medium (not shown).

[0036]

A drive 16 is connected to the camera microprocessor 12, and performs a receipt thereupon of a data with such as a magnetic disk 41, an optical disc 42, a magneto-optical disk 43, or a semiconductor memory 44, which is installed thereto as necessary.

[0037]

Following is a description of a measurement of the mechanical shutter closing time, with reference to Fig. 6. In the present circumstance, it is necessary for the mechanical shutter operation instruction pulse generation circuit 23 to measure a time from a generation of the mechanical shutter operation instruction pulse to a complete closing of the iris/mechanical shutter 2, and thus, a closing time Tclose with respect to Fig. 6 differs from the closing time t1 - t3 that is described with reference to Fig. 3.

Put another way, the closing time Tclose that is depicted in Fig. 6 is equivalent to a sum t1 - t2 of the closing time and the delay time with respect to Fig. 3.

[0038]

First, with respect to a prescribed aperture stop value α, a light emitting body that gives off a given brightness is imaged. The camera microprocessor 12 outputs the mechanical shutter operation timing information to the mechanical shutter operation instruction pulse generation circuit 23, and outputs the electronic shutter control signal to the timing generator 14, such that the electronic shutter drive signal is generated simultaneously with the occurrence of the mechanical shutter operation instruction pulse, as depicted in Fig. 6 (A). The mechanical shutter operation instruction pulse generation circuit 23 generates the mechanical shutter operation instruction pulse, and outputs the mechanical shutter operation instruction pulse thus generated to the driver 15, based on the mechanical shutter operation timing information, whereupon the driver 15 receives the input thereto of the mechanical shutter operation instruction pulse, and drives the iris/mechanical shutter 2. The timing generator 14 receives the input thereto of the electronic shutter control signal, and drives the CCD 3. A timing of a commencement of the exposure with respect

to such a circumstance will herein be treated as T1.

[0039]

The CCD 3 converts the light that is inputted thereto by way of the lens 1 and the iris/mechanical shutter 2 into the electrical signal, in accordance with the electronic shutter drive signal, and supplies the electrical signal thus converted to the analog/digital (A/D) conversion and auto gain control (AGC) circuit 11. The analog/digital (A/D) conversion and auto gain control (AGC) circuit 11 converts the analog signal thus inputted thereto into the digital signal, amplifies the digital signal thus converted, and outputs the digital signal thus amplified to the signal processing circuit 13. The integral value computation circuit 22 of the signal processing circuit 13 integrates a light quantity of each respective pixel of the image data from the signal that is inputted thereto, and outputs an integral value thus computed to the camera microprocessor 12. The integral value of the light quantity that is obtained during the interval of the closing time Tclose will herein be treated as a light quantity A. The camera microprocessor 12 records upon the memory 21 a value of the light quantity A when the timing of the commencement of the exposure is treated as T1.

[0040]

Thereafter, the camera microprocessor 12 fixes a

timing of an occurrence of the mechanical shutter operation instruction pulse, outputs the mechanical shutter operation timing information to the mechanical shutter operation instruction pulse occurrence circuit 23, and outputs the electronic shutter control signal to the timing generator 14, such that a timing of an occurrence of the electronic shutter drive signal will be later than the T1, or, put another way, shorter than the exposure time. As an instance thereof, when the electronic shutter drive signal is controlled so as to be outputted in synchronization with the horizontal synchronization signal, it is possible to measure the exposure time on a per cycle of occurrence of the horizontal synchronization signal basis, while shortening the exposure time thereof. Thus, as depicted in Fig. 6 (B), a light quantity with respect to a timing of a commencement of an exposure Tn, which is later than the timing of the commencement of the exposure T1 that is depicted in Fig. 6 (A), is treated as A′, the timing of the commencement of the exposure Tn thereof is changed while comparing the light quantity A and the light quantity A′, and the timing of the commencement of the exposure Tn is derived when the light quantity A′ goes to zero. A Tn - T1 in such a circumstance is derived as the closing time Tclose. The camera microprocessor 12 records the closing time Tclose in the memory 21 as the closing time Tclose that

corresponds to the aperture stop value α.

[0041]

Whereas in the present circumstance, the timing of the occurrence of the mechanical shutter operation instruction pulse is fixed, and the timing of the occurrence of the electronic shutter drive signal is changed, it would be possible for the closing time Tclose to be derived by fixing the timing of the occurrence of the electronic shutter drive signal, changing the timing of the occurrence of the mechanical shutter operation instruction pulse, and deriving the timing of the occurrence of the mechanical shutter operation instruction pulse when the light quantity A' goes to zero.

[0042]

Thereafter, the aperture stop value is changed, and a measurement of the closing time Tclose is carried out in a manner similar to the process described herein. The camera microprocessor 12 saves the closing time Tclose that corresponds to each respective aperture stop value in the memory 21. It is to be understood that, in order to simplify the measurement thereof, when the closing time Tclose is measured at a plurality of aperture stop values, and the imaging is performed at an aperture stop value that is external to the plurality of aperture stop values thereof, it would be permissible to execute a measurement of a process light

loss quantity and a compensation for a shutter timing (to be described hereinafter) by employing a closing time Tclose with respect to an aperture stop value that is in a neighborhood of the aperture stop value that is external to the plurality of aperture stop values thereof to perform an approximation, such as an approximation by way of a linear approximation.

[0043]

Following is a description of a measurement of a light loss quantity with respect to a circumstance wherein the shutter speed of the electronic shutter is later than the closing time Tclose, with reference to Fig. 7.

[0044]

In a manner similar to the measurement of the closing time Tclose, with respect to a prescribed aperture stop value α, a light emitting body that gives off a given brightness is imaged, with the mechanical shutter opened, and the electronic shutter opened during the closing time Tclose. In such a circumstance, the integral value of the received light quantity that is computed by the integral value computation circuit 22 is treated as a light quantity B. As depicted in Fig. 7 (A), the light quantity B denotes a received light quantity of the CCD 3 when a light quantity loss does not arise from the operation of the closing of the mechanical shutter. The camera

microprocessor 12 records upon the memory 21 a value of the light quantity B that is inputted thereto from the integral value computation circuit 22.

[0045]

Thus, with respect to the prescribed aperture stop value α, the mechanical shutter operation instruction pulse is caused to occur simultaneously with the occurrence of the electronic shutter drive signal, and a light emitting body that gives off a given brightness is imaged thereby. In such a circumstance, the integral value of the received light quantity that is computed by the integral value computation circuit 22 is treated as a light quantity B′. As depicted in Fig. 7 (B), the light quantity B′ denotes a received light quantity of the CCD 3 when a light quantity loss arises from the operation of the closing of the mechanical shutter. The camera microprocessor 12 computes a 1 - B′ / B from a value of the light quantity B′ that is inputted thereto by the integral value computation circuit 22, as well as from a value of the light quantity B that is recorded upon the memory 21, and records the 1 - B′ / B thus computed upon the memory 21 as a light loss quantity X1 with respect to the prescribed aperture stop value α.

[0046]

Thereafter, the aperture stop value is changed, and a measurement of the light loss quantity is carried

out in a manner similar thereto. The camera microprocessor 12 saves a light loss quantity Xn that corresponds to each respective aperture stop value thereof in the memory 21. In the present circumstance, in order to simplify the measurement thereof, when the light loss quantity Xn is measured at a plurality of aperture stop values, and the imaging is performed at an aperture stop value that is external to the plurality of aperture stop values thereof, it would be permissible to execute a process of a compensation for a shutter timing (to be described hereinafter) by employing a light loss quantity Xn with respect to an aperture stop value that is in a neighborhood of the aperture stop value that is external to the plurality of aperture stop values thereof to perform an approximation.

[0047]

Following is a description, with reference to Fig. 8, of the process of the compensation of the shutter timing, employing the light loss quantity X1 to Xn that is described with reference to Fig. 7, when the shutter speed of the electronic shutter is longer than the closing time of the mechanical shutter.

[0048]

As described herein, the AE is executed prior to the imaging, and the camera microprocessor 12 computes an aperture stop value E, and an AE request exposure

time TAE, which is for obtaining a received light quantity β that is capable of obtaining a received light quantity that is adequate for the imaging thereof.

[0049]

Fig. 8 (B) depicts the mechanical shutter operation instruction pulse, the mechanical shutter operation, and the electronic shutter operation, when performing an electronic shutter shift. When performing an actual imaging thereof, the mechanical shutter and the electronic shutter is controlled so as to include an adequate margin and to operate rapidly, within a prescribed time, such that the mechanical shutter is not prevented from closing completely, due to the fixed misalignment of the mechanical shutter thereof, when the odd field is being read out therein. As a consequence thereof, the mechanical shutter operation instruction pulse is outputted at a timing that is faster than the commencement of the reading out of the odd field by a prescribed margin M, as depicted in Fig. 8 (B).

[0050]

The camera microprocessor 12 computes a shutter timing compensation value for compensating for a light loss quantity XnE that corresponds to an aperture stop value E that is computed in turn by the AE, by reading out the light loss quantity XnE thereof from the memory 21, or, when the light loss quantity XnE that

corresponds to the aperture stop value E thereof has not been measured, by employing the light loss quantity Xn that is saved upon the memory 21 to carry out an approximation calculation thereof, and computing the light loss quantity XnE that corresponds to the aperture stop value E thereof, and taking the integral of the light loss quantity XnE, which equals 1 - B' / B, and the closing time Tclose that corresponds to the aperture stop value E thereof. Thus, the camera microprocessor 12 computes the timing of the commencement of the exposure TE with the value of the compensation of the shutter timing thereof being taken into account thereupon.

[0051]

Thus, the camera microprocessor 12 receives an input of the imaging instruction signal from a console unit (not shown), and reads out, from the memory 21, the closing value Tclose that corresponds to the aperture stop value E that is computed by the AE. Thus, the camera microprocessor 12 computes a timing of the occurrence of the electronic shutter drive signal for driving the electronic shutter at the timing of the commencement of the exposure TE, as depicted in Fig. 8 (B), which is faster than the timing of the commencement of the reading out of the odd field by [the AE request exposure timing TAE + (the margin M - the closing time Tclose) + the timing compensation

value], as depicted in Fig. 8 (B), and computes a timing of the occurrence of the mechanical shutter operation instruction pulse that is faster than the timing of the commencement of the reading out of the odd field by the margin M. Thus, the camera microprocessor 12 generates the mechanical shutter operation timing information in accordance with a result of the computation thereof, outputs the mechanical shutter operation timing information thus generated to the mechanical shutter operation instruction pulse occurrence circuit 23, generates the electronic shutter control signal, and outputs the electronic shutter control signal thus generated to the timing generator 14.

[0052]

Thus, the mechanical shutter operation instruction pulse occurrence circuit 23 generates the mechanical shutter operation instruction pulse, in accordance with the mechanical shutter operation timing information, and outputs the mechanical shutter operation instruction pulse thus generated to the driver 15. The driver 15 receives the input of the mechanical shutter operation instruction pulse, and outputs the mechanical shutter drive signal to the iris/mechanical shutter 2. The timing generator 14 receives the input of the electronic shutter control signal, and outputs the electronic shutter drive signal

to the CCD 3. Thus, the iris/mechanical shutter 2 and the CCD 3 operate at the prescribed timing that is depicted in Fig. 8 (B), according to the signal thus inputted thereto. It is possible thereby to obtain the image data whereupon an impact of an insufficient exposure that is caused by the operation of the closing of the mechanical shutter is compensated for.

[0053]

In addition, a method also exists of performing the compensation for the light loss quantity XnE by a compensation for the shutter timing of the mechanical shutter, aside from performing the compensation for the light loss quantity XnE by the compensation for the shutter timing of the electronic shutter, as described herein with reference to Fig. 8 (B).

[0054]

Fig. 8 (C) depicts a shutter operation pulse, an operation of the mechanical shutter, and an operation of the electronic shutter, when performing a mechanical shutter shift. As described herein, the timing of the commencement of the operation of the mechanical shutter and of the electronic shutter is set at the time of the actual imaging of the image such that the mechanical shutter is completely closed at the time of the reading out of the odd field; as an instance thereof, with respect to Fig. 8 (B), the mechanical shutter operation instruction pulse is generated faster than the timing

of the reading out of odd field, by the margin M. Accordingly, even if the commencement of the operation of the mechanical shutter is delayed to an extent, it is possible to close the mechanical shutter completely at the time of the reading out of the odd field, and thus, it is possible to perform the compensation of the light quantity in a manner similar to Fig. 8 (B), by fixing the timing of the operation of the electronic shutter to the timing of the commencement of the exposure TE, in accordance with the AE request exposure time TAE, as is depicted in Fig. 8 (C), and delaying the timing of the occurrence of the mechanical shutter operation instruction pulse by the timing compensation value that is described with reference to Fig. 8 (B). In such a circumstance, however, it is imperative that the mechanical shutter be prevented from not being completely closed from the shift of the timing of the operation of the mechanical shutter to the commencement of the reading of the odd field.

[0055]

Following is a description of a measurement of a light loss quantity with respect to a circumstance wherein a high speed shutter operation is performed such that the shutter speed of the electronic shutter is faster than the closing time Tclose, with reference to Fig. 9 and Fig. 10.

[0056]

The light loss quantity when the high speed shutter operation is performed changes not only as the closing time Tclose of the mechanical shutter and of the aperture stop value, but also as the exposure time of the electronic shutter. Even in a circumstance wherein the closing time Tclose of the mechanical shutter is equivalent thereto, such as is depicted in Fig. 9 (A) and Fig. 9 (B), when a light loss quantity with respect to an exposure time Y1 is treated as X1, and a light loss quantity with respect to an exposure time Y2 is treated as X2, the light loss quantity X1 will take on a variant value from the light loss quantity X2.

[0057]

In addition, even when the exposure value Y2 is equivalent and the closing time Tclose of the mechanical shutter is equivalent, when a closing curve of the mechanical shutter C1, as depicted in Fig. 9 (B), differs from a closing curve of the mechanical shutter C2, as depicted in Fig. 9 (C), the light loss quantity X2 that corresponds to the closing curve C1 will take on a value that differs from a value that is taken on by a light loss quantity X3 that corresponds to the closing curve C2. Given that a misalignment arises with the closing curve of the mechanical shutter, from each respective mechanical shutter thereof, it becomes necessary to compensate for the shutter timing in

accordance with the fixed misalignment of the mechanical shutter, even when the high speed shutter operation is being carried out.

[0058]

First, a light emitting body that emits a fixed brightness is imaged with the mechanical shutter opened, at the prescribed aperture stop value α, and the electronic shutter opened for a prescribed exposure time Y3 of the high speed shutter operation, wherein Y3 is less than Tclose. In such a circumstance, an integral value of a received light quantity that is computed by the integral value computation circuit 22 is treated as a light quantity D. The light quantity D denotes the received light quantity of the CCD 3 when no light quantity loss arises from the operation of the closing of the mechanical shutter, such as is depicted in Fig. 10 (A). The camera microprocessor 12 records, upon the memory 21, the value of the light quantity D that is inputted thereto from the integral value computation circuit 22.

[0059]

Thus, with respect to an exposure time Y3 that is the same as the exposure time Y3, such as is depicted in Fig. 10 (A), the mechanical shutter operation instruction pulse is generated at the prescribed aperture stop value α, and the light emitting body that emits the fixed brightness is imaged

thereby. In such a circumstance, the integral value of the received light that is computed by the integral value computation circuit 22 is treated as a light quantity D′. The light quantity D′ denotes the received light quantity of the CCD 3 when the light quantity loss arises from the operation of the closing of the mechanical shutter, such as is depicted in Fig. 10 (B). The camera microprocessor 12 compares the value of the light quantity D′ that is inputted thereto from the integral value computation circuit 22 with the value of the light quantity D that is recorded upon the memory 21, and if D is greater than D′, then, with respect to an exposure time Yn that is longer than the exposure time Y3, the camera microprocessor 12 images the light emitting body that emits the fixed brightness at the prescribed aperture stop value α, in a manner similar thereto, and records, upon the memory 21, the timing Tn of the commencement of the exposure of the exposure time Yn, wherein D = D′, as the value of the compensation of the shutter timing with regard to the exposure time Y3 of the high speed shutter operation. Put another way, when an exposure time Y3 prior to compensation is instructed as the exposure time of the high speed shutter, it is possible, with respect to the actual imaging, to image an image that experiences no inadequacy of the light quantity by exposing the imaging thereof at the compensated exposure time Yn.

[0060]

In addition, while it is to be understood that it would be preferable to change the aperture stop value and compute the value of the compensation of the shutter timing on a per aperture stop value basis thereof in order to compensate for the shutter timing with a greater degree of precision, it would be possible to obtain a certain degree of precision in the compensation thereof in a circumstance wherein almost no misalignment arises from the aperture stop value with regard to each respective mechanical shutter thereof, even when the curve of the closing of the mechanical shutter that is described with reference to Fig. 9 comprises the fixed misalignment of the mechanical shutter, and even when executing the compensation of the shutter timing as a representative value of the value of the compensation of the shutter timing when the aperture stop is opened.

[0061]

Furthermore, while it is to be understood that it would be preferable to change the shutter speed of the electronic shutter as narrowly as possible and to compute the value of the compensation of the shutter timing on a per shutter speed basis in order to compensate for the shutter timing with a greater degree of precision, it would also be permissible, as an instance thereof, in order to simplify the measuring

thereof, to divide the closing time Tclose into five parts, compute the value of the compensation of the shutter time of each respective high speed shutter operation thereof, and execute the process of compensating for the shutter timing thereof by employing the value of the compensation of the shutter timing with respect to an exposure time that is in a neighborhood of the five exposure times thereof to perform an approximation calculation, when the imaging is carried out with a high speed shutter operation other than the five exposure times thereof.

[0062]

Put another way, upon receipt of the imaging instruction signal, which denotes the high speed shutter operation, the camera microprocessor 12 reads out the value of the compensation of the shutter timing, i.e., the timing of the commencement of the exposure Tn, from the memory 21, and performs the approximation calculation thereof, in accordance with the exposure time of the high speed shutter operation prior to the compensation thereof, and computes a timing of a commencement of an exposure Tn’ that is suited to the high speed shutter operation. Thus, the camera microprocessor 12 generates the mechanical shutter operation timing information, outputs the mechanical shutter operation timing information thus generated to the mechanical shutter operation instruction pulse

occurrence circuit 23, generates the electronic shutter control signal, and outputs the electronic shutter control signal thus generated to the timing generator 14, in accordance with a computation result of the timing of the commencement of an exposure Tn′ thereof.

[0063]

Thus, the mechanical shutter operation instruction pulse occurrence circuit 23 generates the mechanical shutter operation instruction pulse, in accordance with the mechanical shutter operation timing information, and outputs the mechanical shutter operation instruction pulse thus generated to the driver 15. The driver 15 receives the input thereto of the mechanical shutter operation instruction pulse, and drives the iris/mechanical shutter 2. The timing generator 14 receives the input thereto of the electronic shutter control signal, and drives the CCD 3. It is thus possible to obtain the image data that does not suffer from an insufficient light quantity due to the operation of the closing of the mechanical shutter.

[0064]

Whereas a digital camera has been described that employs the iris/mechanical shutter 2 that has been described with reference to Fig. 2 (A), in the present circumstance, it is to be understood that it would be possible to perform the compensation of the shutter timing by way of a process that is similar thereto in a

circumstance wherein the iris 4 and the mechanical shutter 5 is employed, instead of the iris/mechanical shutter 2, such as is described with reference to Fig. 2 (B). It is to be understood that, when employing the iris 4 and the mechanical shutter 5, as described with reference to Fig. 2 (B), the closing time Tclose of the mechanical shutter 5 does not change with the aperture stop value that is determined by the AE mechanism, and thus, it would be permissible to perform the measurement of the closing time Tclose of the mechanical shutter that is described with reference to Fig. 6 without employing the plurality of the aperture stop value therewith.

[0065]

Thus, it would be possible to execute a process that is similar to the measurement of the light loss quantity and the process of the compensation of the shutter timing that is described with reference to Fig. 7 to Fig. 10, by inputting the mechanical shutter drive signal that is outputted from the driver 15 into the mechanical shutter 5, inputting the iris drive signal that is outputted from the driver 15 into the iris 4, and driving the mechanical shutter 5 and the iris 4 by way of the mechanical shutter drive signal and the iris drive signal thereof.

[0066]

It is also possible to execute the processes

described herein in software. The software thereof is installed from a recordable medium, wherein a program that configures the software thereof would be installed upon a computer that is embedded into a dedicated hardware thereof, or else the software thereof would be installed by installing each respective type of program thereof to such as a general purpose personal computer, as an instance, which would be capable of executing each respective type of function thereof.

[0067]

As depicted in Fig. 5, the recordable medium is configured of such as a packaged media, such as the magnetic disk 41, including a floppy disk, the optical disc 42, including a Compact Disk Read Only Memory (CD-ROM) or a Digital Versatile Disk (DVD), the magneto-optical disk 43, including a Mini Disk (MD), or the semiconductor memory 44, whereupon the program thereof is recorded, and which is distributed, separate from the computer, in order to provide the program to the user.

[0068]

In addition, the step that describes the program that is recorded upon the recording medium according to the present specification includes a process that is performed in a chronological order according to the sequence that is disclosed according to the present specification, as well as a process that is executed

either in parallel or individually, rather than being processed exclusively in the chronological order.

[0069]

EFFECT OF THE INVENTION

According to an image processing apparatus, a compensation method of the image processing apparatus, and a program that is recorded upon a recording medium, with respect to a digital camera comprising a mechanical shutter function, a light that is inputted by way of a lens is controlled, the light thereof is shuttered, a timing of the shuttering thereof is controlled, the light thereof is converted into an electrical signal, a timing of the conversion thereof is controlled, an integral value of a light quantity is computed from the electrical signal, a control information is generated, in order to compensate for a loss quantity of an integral value of a light quantity with respect to a light quantity that is suited to the imaging, from the integral value of the light quantity thus computed, and with respect to a plurality of imaging states, and a recording of the control information thus generated is controlled, thereby allowing a compensation, with a high degree of precision, of a light quantity loss arising form a closing operation of a mechanical shutter that comprises a fixed misalignment, regardless of a shutter speed or an aperture stop value of the digital camera

thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 describes a function of a mechanical shutter.

Fig. 2 describes a configuration of a photosensitive function with respect to a digital camera.

Fig. 3 describes a light loss quantity.

Fig. 4 describes an operation of a high speed shutter and a light loss quantity in such a circumstance.

Fig. 5 is a block diagram depicting a configuration of a component that performs a control relating to a photosensitivity of a digital camera, wherein the present invention is applied.

Fig. 6 describes a measurement of a closing time of the mechanical shutter.

Fig. 7 describes a measurement of the light loss quantity.

Fig. 8 describes a process of a compensation of a shutter timing.

Fig. 9 describes a light loss quantity during an operation of a high speed shutter.

Fig. 10 describes a measurement of a timing of a commencement of an exposure that compensates for the light loss quantity during the operation of the high speed shutter.

KEY TO REFERENCE NUMERALS

2. Iris/Mechanical Shutter
3. CCD
4. Iris
5. Mechanical Shutter
12. Camera Microprocessor
13. Signal Processing Circuit
14. Timing Generator
15. Driver
21. Memory
22. Integral Value Computation Circuit
23. Mechanical Shutter Operation Instruction Pulse Generation Circuit

Fig. 1

(A) Without Mechanical Shutter

#1 Vertical Synchronization Signal

#2 Photography of Still Image

#3 Reading Out of Odd Field

#4 Reading Out of Even Field

#5 Light That Is Accumulated Upon CCD

(B) With Mechanical Shutter

#1 Operation of Mechanical Shutter

#2 Open

#3 Close

#4 Vertical Synchronization Signal

#5 Light That Is Accumulated Upon CCD

#6 Photography of Still Image

#7 Reading Out of Odd Field

#8 Reading Out of Even Field

Fig. 2 (A)

1. Lens

2. Iris/Mechanical Shutter

#1 Light

Fig. 2 (B)

1. Lens

5. Mechanical Shutter

#1 Light

Fig. 3

#1 Light Quantity

#2 Light Quantity Desired for Actual Exposure

#3 Timing of Termination of Exposure

#4 Time

#5 Timing of Commencement of Closing of Mechanical Shutter

#6 Light Quantity

#7 Light Loss Quantity

#8 Time

#9 Mechanical Shutter Operation Instruction Pulse

#10 Timing of Completion of Closing

#11 Delay Time

#12 Closing Time

Fig. 4

#1 Mechanical Shutter Operation Instruction Pulse

#2 Open

#3 Operation of Mechanical Shutter

#4 Close

#5 Timing of Commencement of Closing of Mechanical Type Mechanical Shutter

#6 Closing Time

#7 Timing of Completion of Closing

#8 Time

#9 Operation of Electronic Shutter

#10 Voltage Discharge

#11 Exposure Time

#12 Time

#13 Light Loss Quantity

#14 Exposure Time

#15 Time

Fig. 5

1. Lens

2. Iris/Mechanical Shutter

11. Analog/Digital (A/D) Conversion and AGC Circuit

12. Camera Microprocessor

13. Signal Processing Circuit

14. Timing Generator

15. Driver

16. Drive

21. Memory

22. Integral Value Computation Circuit

23. Mechanical Shutter Operation Instruction Pulse Generation Circuit

41. Magnetic Disk

42. Optical Disk

43. Magneto-Optical Disk

44. Semiconductor Memory

#1 Light

#2 Mechanical Shutter Drive Signal

#3 Iris Drive Signal

#4 Electronic Shutter Drive Signal

#5 Horizontal/Vertical Synchronization Signal

#6 Electronic Shutter Control Signal

#7 Aperture Stop Control Signal

#8 Mechanical Shutter Operation Instruction Pulse

#9 Mechanical Shutter Operation Timing Information

#10 To Image Processing Circuit

#11 Imaging Instruction Signal

Fig. 6 (A)

#1 Mechanical Shutter Operation Instruction Pulse

#2 Open

#3 Operation of Mechanical Shutter

#4 Received Light Quantity With Regard to Aperture Stop Value α

#5 Close

#6 Light Quantity A

#7 Operation of Electronic Shutter

#8 Voltage Discharge

#9 Closing Time Tclose

#10 Timing of Completion of Closing

#11 Time

#12 Timing of Commencement of Exposure

#13 Time

Fig. 6 (B)

#1 Open

#2 Operation of Mechanical Shutter

#3 Close

#4 Operation of Electronic Shutter

#5 Voltage Discharge

#6 Light Quantity A′

#7 Timing of Completion of Closing

#8 Time

#9 Timing of Commencement of Exposure

#10 Time

Fig. 7 (A)

#1 Open

#2 Operation of Mechanical Shutter

#3 Received Light Quantity With Regard to Aperture Stop Value α

#4 Light Quantity B

#5 Close

#6 Operation of Electronic Shutter

#7 Voltage Discharge

#8 Timing of Commencement of Exposure T1

#9 Closing Time Tclose

#10 Time

#11 Time

Fig. 7 (B)

#1 Mechanical Shutter Operation Instruction Pulse

#2 Open

#3 Operation of Mechanical Shutter

#4 Close

#5 Received Light Quantity With Regard to Aperture Stop Value α

#6 Operation of Electronic Shutter

#7 Voltage Discharge

#8 Light Quantity B′

#9 Closing Time Tclose

#10 Timing of Completion of Closing

#11 Time

#12 Timing of Commencement of Exposure T1

#13 Time

Fig. 8

#1 Operation of Mechanical Shutter

#2 Operation of Electronic Shutter

#3 Voltage Discharge

#4 Received Light Quantity β

#5 Auto Exposure (AE) Request Exposure Time TAE

#6 Reading Out of Odd Field

#7 Margin M

#8 Mechanical Shutter Operation Instruction Pulse

#9 Shift of Electronic Shutter

#10 Operation of Mechanical Shutter

#11 Operation of Electronic Shutter

#12 Compensated Light Loss Quantity XnE

#13 Received Light Quantity β

#14 Voltage Discharge

#15 Timing of Commencement of Exposure TE

#16 Closing Time Tclose

#17 Light Loss Quantity XnE

#18 Auto Exposure (AE) Request Exposure Time TAE

#19 Timing Compensation Value

#20 Reading Out of Odd Field

#21 Timing Compensation Value

#22 Mechanical Shutter Shift

#23 Mechanical Shutter Operation Instruction Pulse

#24 Operation of Mechanical Shutter

#25 Operation of Electronic Shutter

#26 Received Light Quantity β

#27 Voltage Discharge

#28 Auto Exposure (AE) Request Exposure Time TAE

#29 Timing of Commencement of Exposure TE

#30 Closing Time Tclose

#31 Reading Out of Odd Field

Fig. 9

#1 Mechanical Shutter Closing Curve C1

#2 Light Loss Quantity X1

#3 Time

#4 Exposure Time Y1

#5 Mechanical Shutter Closing Curve C1

#6 Light Loss Quantity X2

#7 Exposure Time Y2

#8 Mechanical Shutter Closing Curve C2

#9 Light Loss Quantity X3

#10 Time

#11 Exposure Time Y2

#12 Closing Time Tclose

#13 Time

Fig. 10

#1 Operation of Mechanical Shutter

#2 Operation of Electronic Shutter

#3 Received Light Quantity With Regard to Aperture Stop Value α

#4 Voltage Discharge

#5 Timing of Commencement of Exposure T1

#6 Exposure Time Y3

#7 Light Quantity D

#8 Time

#9 Operation of Mechanical Shutter

#10 Operation of Electronic Shutter

#11 Received Light Quantity With Regard to Aperture Stop Value α

#12 Voltage Discharge

#13 Light Quantity D'

#14 Time

#15 Operation of Mechanical Shutter

#16 Operation of Electronic Shutter

#17 Received Light Quantity With Regard to Aperture

Stop Value α

#18 Voltage Discharge

#19 Timing of Commencement of Exposure Tn

#20 Mechanical Shutter Operation Instruction Pulse

#21 Light Quantity D′

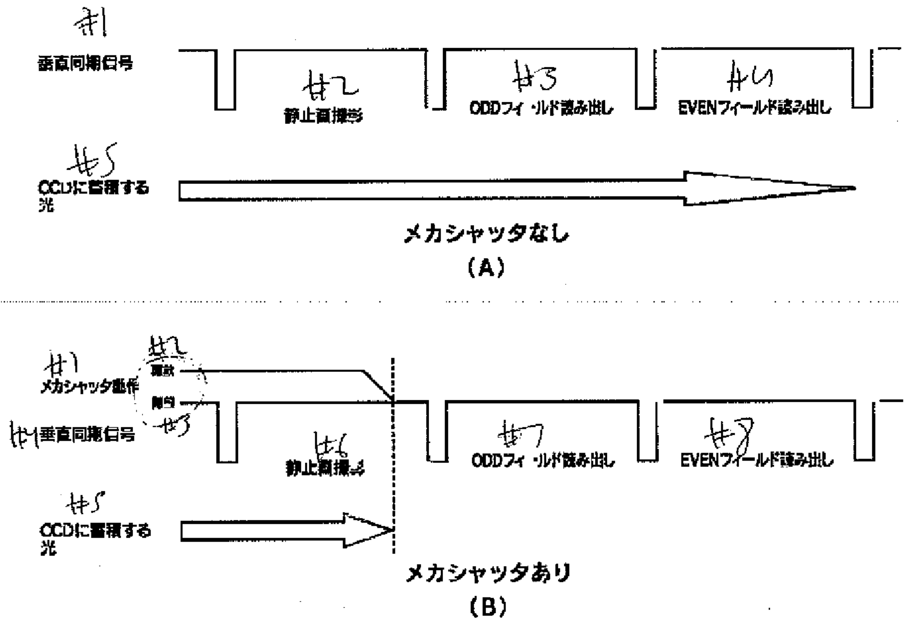
#22 Exposure Time Yn

#23 Closing Time Tclose

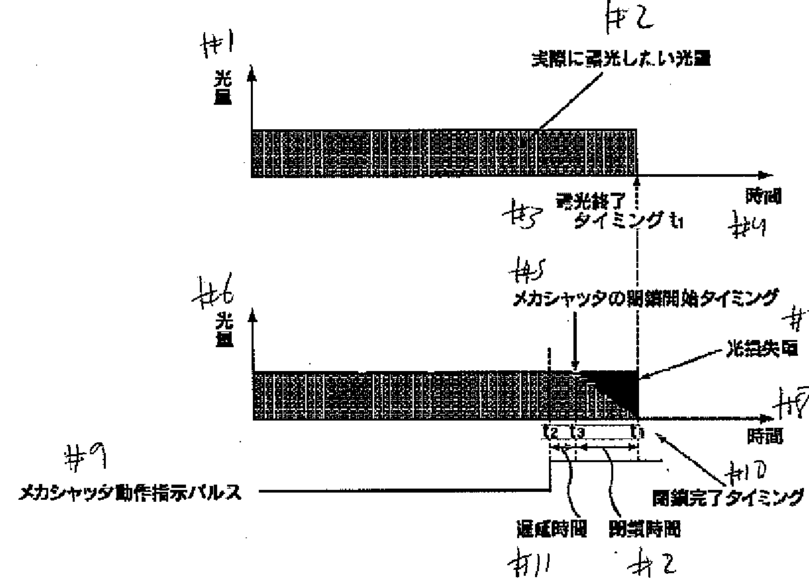
#24 Time

【図4】高速シャッタ動作とその場合の光損失量を説明するための図である。
【図5】本発明を適応した電子カメラの受光に関する制御を行う部分の構成を示すブロック図である。
【図6】メカシャッタの閉鎖時間の測定について説明するための図である。
【図7】光損失量の測定について説明するための図である。
【図8】シャッタタイミング補正処理について説明するための図である。
【図9】高速シャッタ動作時の、光損失量について説明するための図である。
【図10】高速シャッタ動作時の光損失量を補正する露光開始タイミングの測定について説明するための図である。
【符号の説明】
2　iris兼メカシャッタ，　3　CCD，　4　iris，　5　メカシャッタ，12　カメラマイコン，　13　信号処理回路，　14　タイミングジェネレータ，　15　ドライバ，　21　メモリ，　22　積分値演算回路，　23メカシャッタ動作指示パルス発生回路

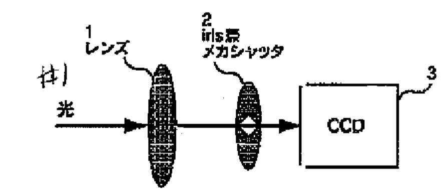
【図1】



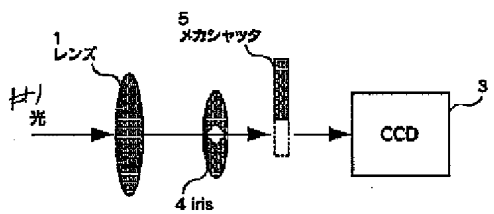
【図3】



【図2】

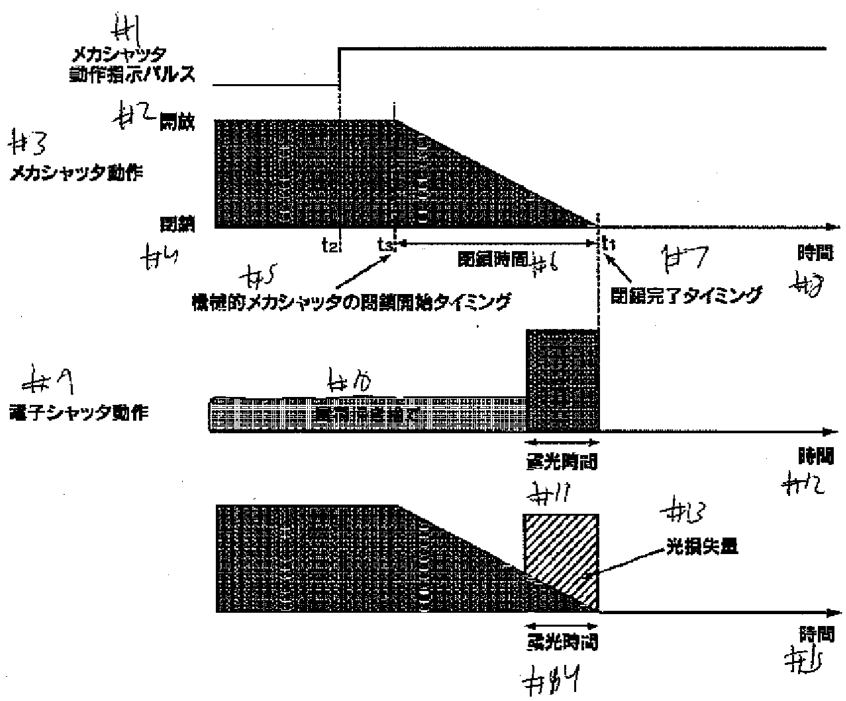

1
レンズ
2
iris兼
メカシャッタ
光
CCD
3

(A)

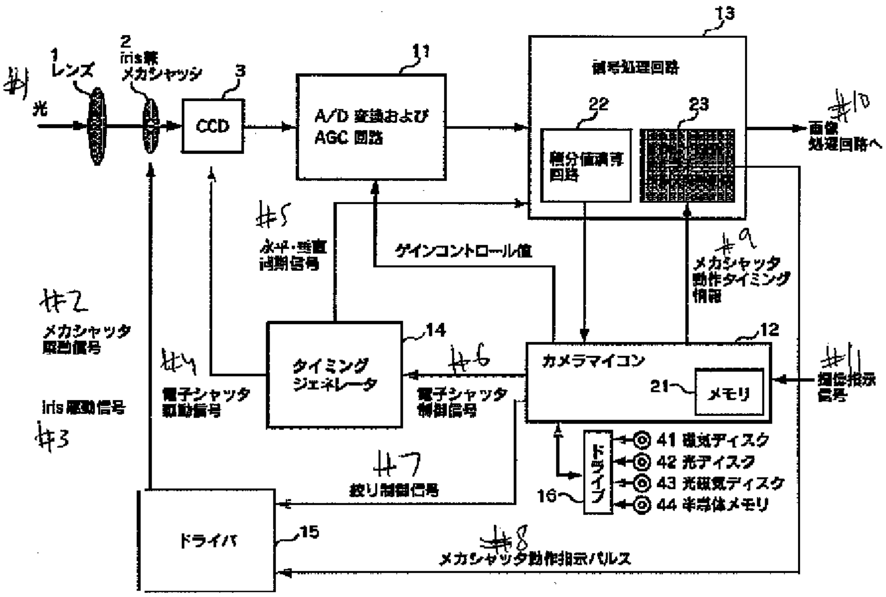

1
レンズ
5
メカシャッタ
光
CCD
3
4 iris

(B)

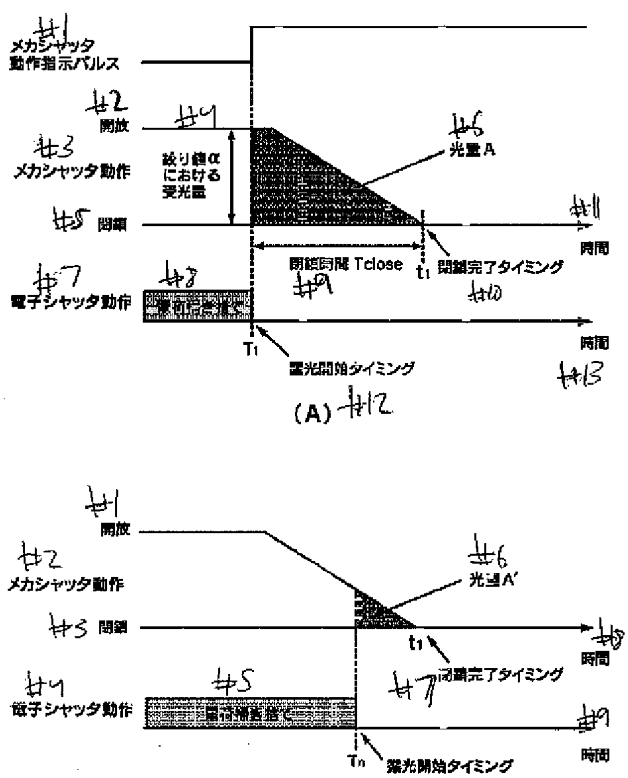
【図4】


メカシャッタ
動作指示パルス
開放
メカシャッタ動作
閉鎖
t2
t3
閉鎖時間
t1
時間
機械的メカシャッタの閉鎖開始タイミング
閉鎖完了タイミング
電子シャッタ動作
露光時間
時間
光損失量
露光時間
時間

【図5】

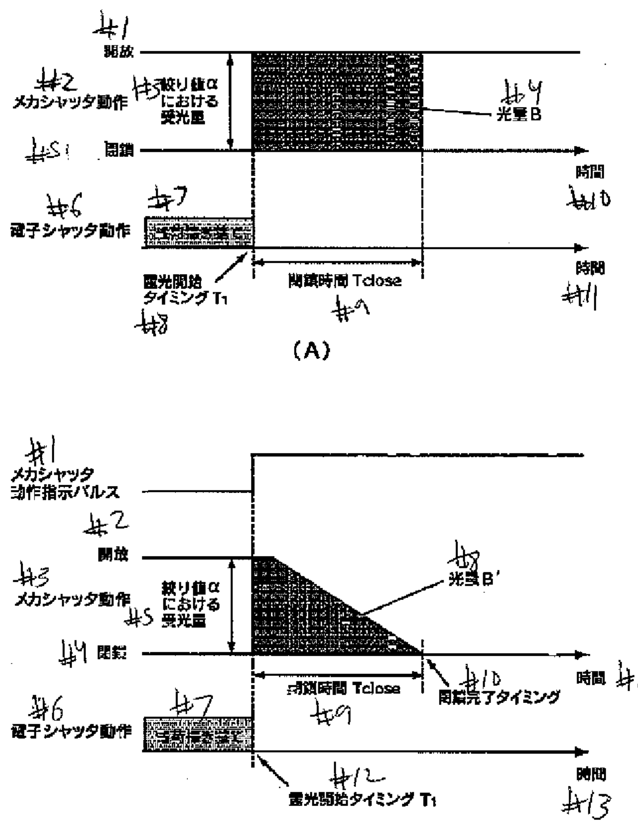

光
1 レンズ
2 iris兼メカシャッタ
3 CCD
11 A/D 変換および AGC 回路
13 信号処理回路
22 積分値演算回路
23
画像処理回路へ
水平・垂直同期信号
ゲインコントロール値
メカシャッタ動作タイミング情報
メカシャッタ駆動信号
電子シャッタ駆動信号
iris駆動信号
14 タイミングジェネレータ
電子シャッタ制御信号
12 カメラマイコン
21 メモリ
撮像指示信号
16 ドライブ
41 磁気ディスク
42 光ディスク
43 光磁気ディスク
44 半導体メモリ
絞り制御信号
15 ドライバ
メカシャッタ動作指示パルス

【図6】


メカシャッタ動作指示パルス
開放
メカシャッタ動作
閉鎖
絞り値αにおける受光量
光量A
時間
閉鎖時間 Tclose
t1
閉鎖完了タイミング
電子シャッタ動作
T1
露光開始タイミング
時間
開放
メカシャッタ動作
閉鎖
光量A'
t1
閉鎖完了タイミング
時間
電子シャッタ動作
Tn
露光開始タイミング
時間

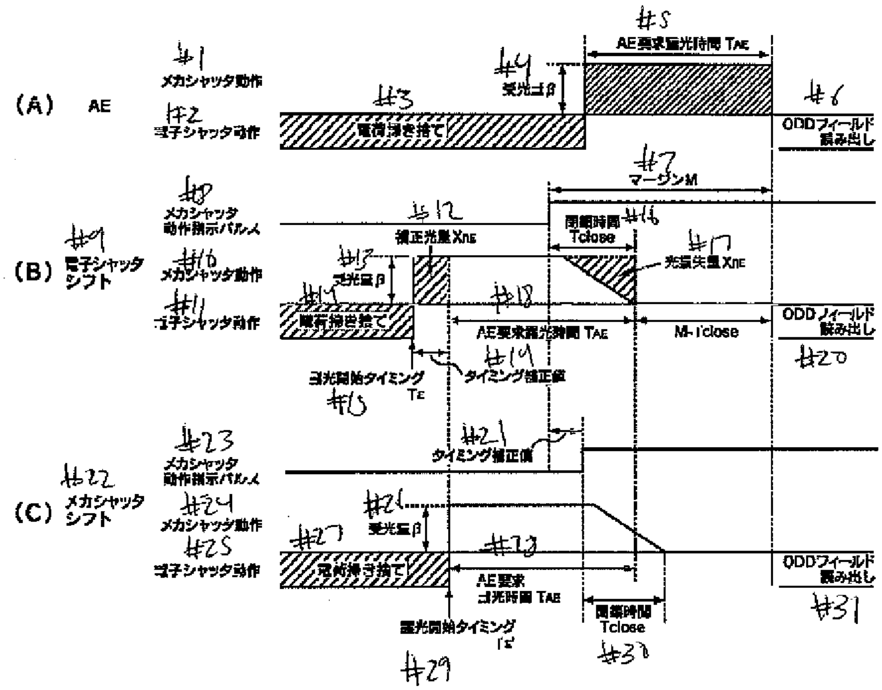
(A) (B)

【図7】

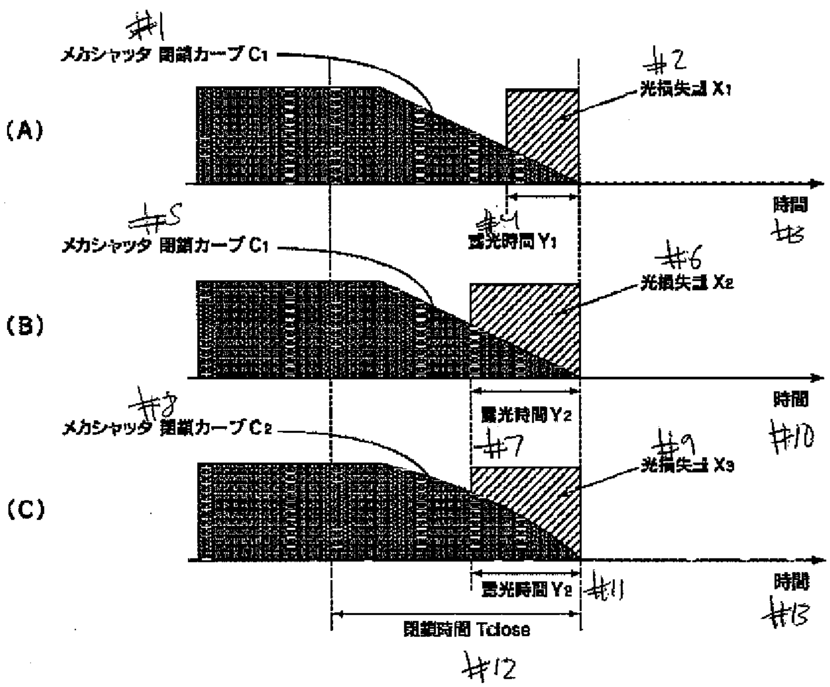

開放
メカシャッタ動作
絞り値αにおける受光量
光量B
閉鎖
時間
電子シャッタ動作
時間
露光開始タイミング T1
閉鎖時間 Tclose
メカシャッタ動作指示パルス
開放
メカシャッタ動作
絞り値αにおける受光量
光量B'
閉鎖
閉鎖時間 Tclose
閉鎖完了タイミング
時間
電子シャッタ動作
露光開始タイミング T1
時間

(A) (B)

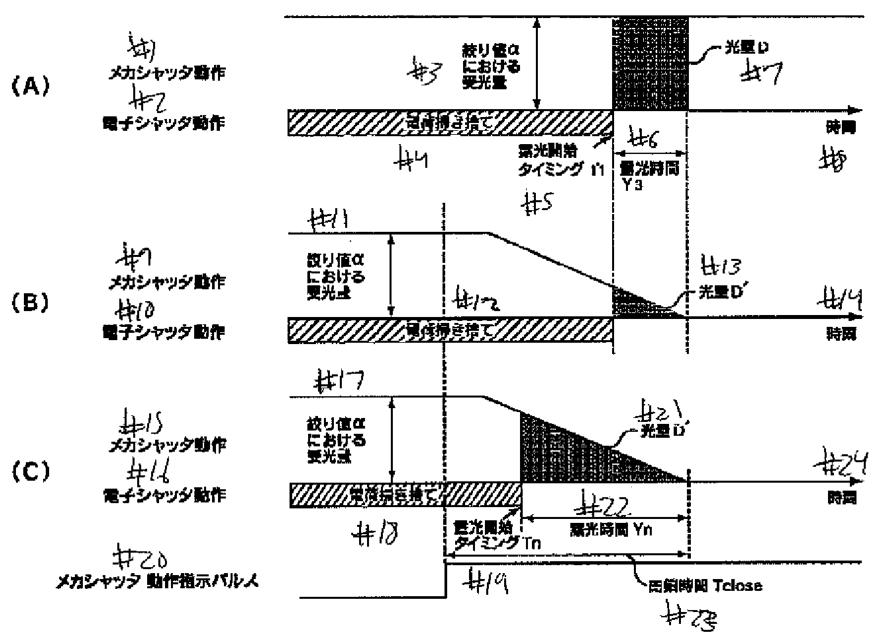
【図8】


(A)
AE
メカシャッタ動作
電子シャッタ動作
電荷掃き捨て
受光量β
AE要求露光時間 TAE
ODDフィールド読み出し
(B)
電子シャッタシフト
メカシャッタ動作指示パルス
メカシャッタ動作
電子シャッタ動作
マージンM
閉鎖時間 Tclose
補正光量 XnE
光損失量 XnE
受光量β
電荷掃き捨て
AE要求露光時間 TAE
M-Tclose
ODDフィールド読み出し
露光開始タイミング TE
タイミング補正値
(C)
メカシャッタシフト
メカシャッタ動作指示パルス
メカシャッタ動作
電子シャッタ動作
タイミング補正値
受光量β
電荷掃き捨て
AE要求露光時間 TAE
閉鎖時間 Tclose
ODDフィールド読み出し
露光開始タイミング TE

【図9】


(A)
メカシャッタ 閉鎖カーブ C1
光損失量 X1
露光時間 Y1
時間
(B)
メカシャッタ 閉鎖カーブ C1
光損失量 X2
露光時間 Y2
時間
(C)
メカシャッタ 閉鎖カーブ C2
光損失量 X3
露光時間 Y2
時間
閉鎖時間 Tclose

【図10】



フロントページの続き

Fターム(参考) 5C022 AA13 AB04 AB12 AB17 AC42
AC52 AC54 AC56 AC69
5C024 AX01 BX01 CX37 CX56 DX04
DX07 EX31 EX34 GY01 GZ01
HX21 HX23 HX30 HX31 HX57
JX14
5C052 AA17 AB02 CC01 DD02 EE08
GA02 GB01 GD01 GD03 GE06
GF01